

Dealing with Introduced Diseases—Hawaiian Style

by Greg Massey, DVM

The endangered Hawaiian Crow ('Alala, *Corvus hawaiiensis*) once occupied a range on the Big Island of Hawaii extending from the northwest side of the island south and east to the Kilauea crater. However, in recent years, the population declined to less than 20 wild individuals occupying a small area of private land on the southwest portion of the island. The causes for this decline are numerous and difficult to define. However, one of the most obvious contributing factors has been the effect of diseases that were introduced to the island along with their avian carriers. Those introduced birds, whose immune systems coevolved with these diseases, were able to deal with these illnesses and survive. However, Hawaii's endemic species lacked the weapons necessary to combat these new enemies.

For many years, it has been speculated that avian poxvirus and avian malaria were the two main diseases that played a role in the decline of Hawaiian Crows. Historical evidence has documented 'Alala infected by both of these pathogens. Mosquitos, introduced to Hawaii in 1826, are the primary means of transmission for both diseases.

Avian poxviruses are members of the genus Avipoxvirus and infect the epithelial cells in a susceptible bird. As the virus multiplies it creates damage within the cell resulting in swelling, inflammation, and, eventually, cell death. The cutaneous form usually appears as a swelling or scab on the bird's face or feet. An even more serious problem develops if these lesions become secondarily infected with bacteria. The diphtheritic (wet) form affects the bird's oral cavity, esophagus, and upper respiratory system. Depending on the strain of virus and the host's immune status, this form can often be fatal. Pox viruses can survive for long periods of time in the environment waiting for the opportunity to infect a new host. They are transmitted by mechanical vectors. This means that the

virus can be transmitted by any object that brings it into contact with a susceptible host. However, the epithelial surface must provide an opening through which the virus can become established. That's why mosquitos are such perfect vectors. They contact the virus with their mouth parts while feeding on an infected host and the infection is transferred to a susceptible bird during the next meal. When the mosquito feeds on the uninfected bird, it penetrates the skin allowing the virus to invade.

Avian malaria is a parasite that infects red blood cells resulting in their destruction. As more and more red cells are lost, the bird becomes progressively anemic. If the anemia is severe, the bird becomes an easy target for predators because it is too weak to escape. If it's not preyed upon, the bird may die from starvation because it is too weak to forage for food. The species of parasite that infects Hawaiian birds, *Plasmodium relictum*, is not the same organism that causes malaria in humans. However, it is transmitted in the same manner as human malaria. A female mosquito takes a blood meal from an infected host whose red blood cells contain the parasite. Then the organism undergoes a change within the mosquito's body and migrates to the salivary glands so that it can be inoculated into a susceptible host the next time the mosquito feeds. Once *P. relictum* enters the new host, the process starts all over again.

Until recently, no 'Alala with a malaria infection had been treated and followed through the clinical course of this disease. However, thanks to a cooperative agreement between private land owners, the U.S. Fish and Wildlife Service (USFWS), and the State of Hawaii, several birds have been diagnosed, treated, and their clinical responses documented. These crows were part of an effort involving the USFWS, the State of Hawaii's Olinda Endangered Species Propagation Facility and The Peregrine Fund to quickly increase the existing popu-

lation through active management of the wild and captive flocks during the past two breeding seasons.

At about two months of age, birds hatched by The Peregrine Fund aviculturists from eggs removed from wild nests or bred in captivity at the Olinda Facility were placed into a large release aviary erected within the range of the few remaining wild 'Alala. Prior to being placed in this aviary, the birds had been reared in mosquito-proof facilities to prevent any exposure to malaria while their immune systems were maturing. Research showed that the area surrounding the release aviary had a high density of mosquitos carrying the infective stage of the malaria parasite. Therefore, when the birds were released into the aviary, they were inevitably exposed to this disease. Some of the birds survived their initial exposure to malaria without requiring medical treatment. However, this was only determined after several of the birds showed clinical signs of illness which did require therapy. The anemia produced in these birds was severe. It is likely that if any of these debilitated birds had been in a wild setting where they were forced to forage for their food instead of having it provided to them, they would not have survived. Therefore, it is fortunate that the cooperating parties have agreed to use this new recovery strategy to assist this species in overcoming at least one of the many hurdles it faces in today's altered environment.

Two of the birds in the aviary also developed lesions consistent with avian pox. Confirmation of the diagnosis is still pending. However, one of the birds did require medical treatment for a secondary bacterial infection associated with the cutaneous lesion that developed on its toe.

Hopefully, future 'Alala that are artificially incubated and handreared will be released in the manner previously outlined so that they can be monitored and assisted through their initial encounters with malaria and pox. It's true that the risk of disease is only one factor affecting the recovery of this species, but efforts are also being made to address other problems (mosquitos, habitat alteration, introduced predators, etc.) that threaten the survival of Hawaii's crows and other forest birds. ➤